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Peers and Culture

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Abstract

We analyze the evolution of culture when parents socialize children to the cultural variants that maximize child lifetime utility. Parents invest in cultural transmission taking into account that children are also influenced by peers. We model the influence of peers by assuming that children observe different cultural variants in their peer group, assign merit to them and adopt one variant, following a probabilistic adoption rule. We show that cultural diversity is sustainable even if all parents strive to transmit the same variant. We also show that a parental demand for cultural pluralism does not guarantee cultural diversity.

Journal of Economic Literature Classification codes: D10, I20, J13.
Keywords: Cultural transmission, cultural diversity, peer groups, oblique transmission.

I. Introduction

The study of cultural transmission is motivated by the evidence of slow cultural convergence and persistence of cultural diversity, reported in Glazer and Moynihan (1963) and Borjas (1995). The evidence contradicts the predictions of rapid convergence and assimilation of cultures common to the early sociological theories that described American society as a *melting pot*. Recent economic models of cultural transmission give one account of why cultures remain diverse.[1] Bisin and Verdier (2000) argue that "the persistence of cultural traits, ..., is the consequence of the demand for "cultural pluralism" on the part of ethnic, religious, and racial minorities."

This conclusion, however, is at odds with a number of observations. For instance, it is hard to attribute events such as the suburban riots in France in the fall of 2005 or the surge of religious fundamentalism among some groups of second generation immigrants, to an active endeavor of parents to transmit their own variants. Many negative social phenomena involve children and adolescents whose parents have tried hard, and often

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[1]See Bisin and Verdier (2006) for a recent survey of the literature.

succeeded in becoming well-integrated in society. There are also plenty of examples of parents who strive in vain to preserve elements of cultural identity or pluralism, such as minority dialects or customs. A common root of the parental failure to preserve diversity is the fact that children rather learn from their peers than from their parents. For instance, Harris (1998) argues that it is the aim of children and adolescents to fit in and be successful in their peer group. Thus, limiting parents' influence on the socialization process (see also Pinker, 2002). Also the economic literature on identity formation focuses on the young individuals adoption of values and behavior in order to be successful children rather than on the inter-generational transmission of culture and values from parents to children (Akerlof and Kranton, 2000 and 2002).

The purpose of this paper is to formulate a model of cultural transmission which recognizes that children have a role in adopting culture, and which does not rest on parental demand for pluralism as an explanation for diversity. We do so in a model similar to Bisin and Verdier (2000) and Hauk and Saez-Marti (2002) in which altruistic parents transmit cultural traits and values to their children (vertical transmission), taking into account that children are also influenced by the society in which thy live(oblique transmission).[2]

Our main theoretical contribution is to formalize the merit guided learning on the part of children described by Boyd and Richerson (1985). In particular, we assume that children observe different cultural variants in their peer group, assign merit to the variants and adopt one of them following a probabilistic adoption rule which depends on relative merits. This learning process gives rise to a general oblique transmission function which allows for transmission to be biased in favor of some traits.

The standard case discussed in the cultural transmission literature, which assumes that the probability of acquiring a variant equals its proportion in the population (linear or unbiased oblique transmission), is encompassed by our model as a special case. Linear transmission results if children assign equal and constant merit to all the variants of a trait or if children have only one randomly drawn peer, which is in fact the maintained assumption in the previous literature. However, we show that any departure from these assumptions results in some form of biased (non-linear) transmission.

In particular, under the reasonable assumption that children learn from a larger group of randomly drawn peers, our model can generate the positive, negative and frequency dependent (or conformism) biases that were already discussed in the cultural anthropology literature (see, e.g., Boyd and Richerson, 1985).[3]

While previous models of cultural transmission have assumed demand for pluralism, a

[2]Oblique transmission is distinguished from *vertical* transmission which captures transmission of culture form parents to children. *Horizontal* transmission, is the transmission of culture from individuals of the same generation. This terminology was first introduced by Cavalli Sforza and Feldman (1981).

[3]Conformism is not new to economics. It has been show to arise when rational agents use the decisions and behaviors of others as sources of information about the qualities and of a good or the virtues of a trait, Becker (1991), Banerjee (1992), and Bikhchandani, Hirshleifer and Welch (1992). Conformism can also result when agents value status in a group, Bernheim (1994) and Becker and Murphy (2002) or because of mutual externalities from coordination.

further contribution of this paper is to provide a model which enables the study cultural dynamics when parents agree on which cultural variant is desirable. This is important. Although there are obvious examples where parents actively promote their own variant, e.g. language and religion, this is far less obvious when it comes to traits and values associated with low status and poor market outcomes.[4]

Biased oblique transmission has different implications for the evolution of culture compared to linear transmission. In particular, we find that biases open up for multiple stable equilibria such that initial conditions regarding the prevalence of cultural variants, may determine whether there will be assimilation or diversity in the long run.

Contrary to previous models, our theory can explain why some variants become extinct, even though parents are willing to actively promote them. In particular, extinction may occur if children are conformist and the fraction of holders is small enough. To the extent that some elements of cultural diversity are valued in society, our theory justifies policy intervention in defense of minoritarian traits and cultures. Our theory also shows that the survival of sub-cultures that are regarded as a burden to society, e.g. criminality or religious fundamentalism, does not hinge on active investments of parents nor on the demand of cultural pluralism. The key may again be the nature of the learning and socialization process. Even a variant that no parent promotes may persist if children are positively biased in favor of it, or if they are conformist and their environment is dominated by the variant. Therefore, policies aimed at combating degenerate social phenomena and at promoting children's adoption of mainstream variants (e.g., "Head Start") need not imply a conflict with parental preferences as was implicit in the conclusion of previous theories.

The paper is organized as follows. First we present a general framework of cultural transmission where parents can chose to promote the adoption of either of two variants of a cultural trait. Second, we develop a model of merit guided oblique transmission with the aim of capturing the young individuals' adoption of cultural traits from their older peers. Third, we derive the implications for optimal vertical transmission of different biases in the oblique transmission. Section four characterizes the cultural dynamics and discusses some comparative statics. Section five concludes.

II. Cultural transmission

This section considers how young agents come to adopt cultural traits that later in life influence adult behavior and success. We assume that socialization takes place in childhood in the family through *vertical transmission*, and in society through *oblique transmission.* In the period after, children reach adulthood and it is from that period on that cultural values and traits adopted in childhood are important determinants of wellbeing.

Parents are altruistic and willing to spend resources and nurturing efforts in order to maximize their children's future wellbeing. We consider both the case when parents

[4] However, not even language and religion are neutral with respect to economic success. See Gruber (2005). A growing empirical literature is also showing that given names are social markers with economic consequences, e.g. Fryer and Levitt (2004).

socialize their children to their own cultural variant and the case when parents invest in cultural variants different from their own. For instance, overweight parents may try to induce children not to adopt their own unhealthy eating habits and disorganized parents may try to get their child to keep his room tidy.

Assume a trait with two cultural variants, a and b. While children are born naive and malleable, adults remain of the same type through the rest of their life time, once they have been socialized to either of the variants. More formally, parents, as in Bisin and Verdier (2001), choose the probability, $\tau_i \geq 0$, that the child learns the i-variant through vertical transmission. If the parent fails in influencing his child (this happens with probability $(1-\tau_i)$), the child can still be socialized to the i-variant of the trait by society through a process of oblique transmission.

Let $q \geq 0$ be the proportion adults (socialized agents) holding the a-variant. The remainder are of type b. Consider a parent trying to transmit the a-variant. If the parent exerts effort $\tau_a \geq 0$, the total probability that the child adopts a is given by:

$$x(\tau_a, q) = \tau_a + (1-\tau_a) f(q), \tag{1}$$

where $f(q)$ captures the process of oblique transmission by which the "naive" child is influenced by society (peers). Note that in all previous economic models of cultural transmission the oblique transmission is linear, $f(q) = q$ (Bisin and Verdier, 2001; Hauk and Sáez-Martí, 2002; Sáez-Martí and Zenou, 2005).

A parent who instead wants to promote the b-variant will choose $\tau_b \geq 0$. Then the child can only adopt the a-variant as a result of oblique transmission:

$$x(\tau_b, q) = (1-\tau_b) f(q). \tag{2}$$

Note that when promoting the a-variant, parents can increase the probability that the child adopts the a-variant beyond what would be the case if the child was exposed only to peers, while the child of a parent promoting the b-variant will necessarily adopt the a-variant with smaller probability: $x(\tau_b, q) \leq f(q) \leq x(\tau_a, q)$.

We assume that the oblique transmission function $f : [0,1] \to [0,1]$ is a twice continuously differentiable, increasing function with $f(0) = 0$, $f(1) = 1$ and with at most one $\hat{q} \in (0,1)$ such that $f(\hat{q}) = \hat{q}$. In the next section we discuss its microfoundations in detail, but before that, let us consider the nurturing costs of parents.

Active nurturing is a costly undertaking. We denote by $c_i(\tau)$ the cost born by a parent who chooses nurturing effort τ to transmit variant $i \in \{a, b\}$. We assume that $c_i : [0,1] \to R^+$ is twice continuously differentiable and convex with $c_i(0) = 0$, $c_i'(0) = 0$, $c_i'(\tau)/c_i''(\tau) < 1$ and $\lim_{\tau \to 1} c_i(\tau) = +\infty$. The later assumption guarantees that no parent completely determines the variant of his child. We assume that the cost of transmitting a particular variant is equal across parental types.[5]

[5] It is straightforward to generalize the analysis and assume that costs differs across type of parents. For instance that costs could be higher when transmitting the "other" variant. The results would not change qualitatively.

Since the parent's choice of τ_a (or τ_b) uniquely determines the probability x that the child adopts the a-variant of the trait, we can, using (1) and (2), solve for τ_b and τ_a and write the nurturing cost directly as a function of the probability of adopting the a-variant, x (instead of τ_b and τ_a):

$$C(x,q) = \begin{cases} c_a((x - f(q))(1 - f(q))^{-1}) \text{ if } x \geq f(q) \\ c_b((f(q) - x)f(q)^{-1}) \text{ if } x \leq f(q). \end{cases} \tag{3}$$

The assumptions imposed on $c_i(\tau)$ imply that $C(f(q), q) = 0, \lim_{x \to 0} C(x,q) = +\infty$ for all $q \in (0,1]$ and $\lim_{x \to 1} C(x,q) = +\infty$ for all $q \in [0,1)$.

Parents care about the child's wellbeing in adulthood. We denote by V^{ij} the utility a parent of type i attaches to nurturing a child of type j. It is not the purpose of this paper to model the determination of V^{ij}. However, what is important is that the cultural variant adopted by the child is expected to affect the child's wellbeing in adult life and that parents care about this. Hence, we will make no assumptions regarding the relative magnitudes of the V^{ij}'s. Instead we will consider two possibilities, either parental preferences are homogenous in the sense that the sign of the difference $V^{ia} - V^{ib}$ is the same for parents i and j. We call this case *melting pot* alluding to the general idea behind the melting pot theories that parents were all striving for a common *American Dream*. The other possibility is that parents disagree: We call this *demand for pluralism* when $V^{ba} - V^{bb} < 0 < V^{aa} - V^{ab}$.

In their nurturing efforts, i-type parents choose the probability $x \in [0,1]$ that the child acquires the a-variant by maximizing the expected value of offspring wellbeing net of nurturing costs:

$$\max_{x \in [0,1]} (xV^{ia} + (1-x)V^{ib}) - C(x,q). \tag{4}$$

Before we go on to characterize the optimal nurturing efforts of $a-$ and $b-$type parents, we explore the determinants of the process of oblique transmission function $f(q)$. It is clear from (3) that this process is crucial for the effective costs of nurturing.

III. Peers and oblique transmission

We assume that the process of oblique transmission through which the young agent adopts cultural traits from society is the result of interaction with a group of peers (role models) of a given size G. This peer group consists of already socialized individuals. For analytic simplicity we assume that the peers are randomly selected from the whole population.[6] Peer group interaction allows us to model the agents adoption of culture as the result of an evaluation of the relative merit of the variants of traits, observed in his peers, by the young agent.

In contrast, the standard assumption of previous economic models of cultural transmission has been that the young agent is randomly matched to *one* role-model from whom the variant is copied. This process gives rise to an unbiased oblique transmission function, $f(q) = q$, and implies that children adopt each of the variants with a probability equal to

[6] Assuming that the peers are selected from a sub-population of slightly older agents who were recently socialized, yields the same qualitative results. See Hauk and Sáez-Martí (2002).

their proportion in the community. However, as discussed in Boyd and Richerson (1985), oblique transmission need not be unbiased, in particular if young agents adopt cultural traits based on some form of evaluation of their merits.

There are three qualitatively different biases discussed in the sociobiological literature, positive, negative and frequency-dependent bias.

Positive bias: The probability that the naive individual acquires variant a is always greater than if he had selected a model at random, $f(q) > q \ \forall q \in (0,1)$ (see Figure 1, *i*)).

Negative bias: The probability that the naive individual acquires variant a is always smaller than if he had selected a model at random, $f(q) < q \ \forall q \in (0,1)$ (see Figure 1, *ii*)).

Conformism or frequency-dependent bias: When the frequency of variant a in the community is greater (smaller) than $\hat{q}$, the probability that a naive individual acquires a is increased (decreased) relative to the unbiased transmission, $f(q) \gtreqless q$ for $q \gtreqless \hat{q}$. "Pure" conformism corresponds to $\hat{q} = 1/2$.(see Figure 1, *iii*))

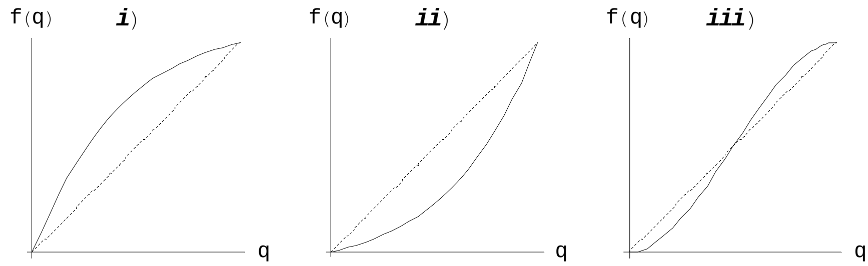

Figure 1: i) positive bias, ii) negative bias and iii) frequency dependent bias.

In order to provide microfoundations for biased transmission, we introduce the notion of “merit”, as an attempt to capture how children view and copy traits from peers in order to be "successful" children and fit in. This aim on the part of children and adolescents is extensively discussed in Harris (1998), and in Akerlof and Kranton (2000, 2002).

More precisely, we assume that after observing the cultural variants of his peers, the naive agent assigns merit to the different variants and follows a probabilistic rule where the probability of adopting a variant is given by its relative merit in the peer group. More specifically, assume that young agents assign merit $m_i(n, G)$ to trait i, where $n \leq G$ is the number of i-type peers. As discussed in the introduction, this merit may depend on some form of predisposition, be inferred by a process of experimentation or from the "success" or salience of some peer(s) holding the trait. This inferred merit may also depend on the proportion, n/G, of peers holding the trait.[7] Let

$$m_i(n, G) = \bar{m}_i + k \ g(\frac{n}{G}) \quad i = a, b \tag{5}$$

[7] This would be rational if it was the case that evolutionary forces had acted so as to increase the frequency of better variants.

where $\bar{m}_i$ and k are non-negative constants, $g(0) = 0$, $g(1) = 1$ and $g(\frac{n}{G}) < g(\frac{n+1}{G})$. If $k = 0$, merit is constant and independent of frequency.

Denote by $P(i|n, G)$ the conditional adoption probability, i.e. the probability with which the young agent adopts trait i when n agents among the G peers are of type i.

Assumption 1: The conditional probability of adopting the a-variant of the trait is given by the sum of the merit of the a-type peers relative to the total merit in the peer group:

$$P(a|n, G) = \frac{n\ m_a(n, G)}{n\ m_a(n, G) + (G - n)\ m_b(G - n, G)}. \tag{6}$$

It follows from this assumption that the naive agent can only adopt variants that are represented in the peer group and that the probability of adoption of a variant increases with the number of peers who hold the variant.

Assumption 2: The oblique transmission function $f(q)$ is the unconditional probability with which the child adopts the a-variant,

$$f(q) = \sum_{n=0}^{G} \binom{G}{n} q^n (1 - q)^{G-n} P(a|n, G). \tag{7}$$

Assumption 2 states that the oblique transmission process results from merit based adoption of traits (Assumption 1) from a randomly selected peer group of size G. It will prove useful to derive some implications of the properties of the conditional adoption probability for the oblique transmission function $f(q)$.

Lemma 1 *$f(q) = q$ for all q iff $P(a|n, G) = \frac{n}{G}$ for all $n = 0, 1..., G$.*

Proof. See Appendix ■

It is clear from Lemma 1 that if the agent has only one role model, $G = 1$, the only possible transmission function is unbiased. If $G > 1$, linear or unbiased transmission, $f(q) = q$, requires very strong conditions on $P(a|n, G)$. It is also worth noting that, any degenerate conditional adoption probability i.e. $P(a|n, G) \in \{0, 1\}$ $\forall n$ will give rise to non-linear transmission. Examples of such degenerate adoption rules are to follow the majority or to adopt the trait held by the most successful peers.

Proposition 1 shows, however, that a probabilistic, (non-degenerate) conditional adoption function as proposed in (6), allows us to generate all four transmission functions depicted in Figure 1. In addition, we can also generate a *biased* frequency dependent transmission function.

Proposition 1 *Under assumptions 1 and 2, the oblique transmission function is*
(i) unbiased iff $k = 0$ and $\bar{m}_a = \bar{m}_b$.
(ii) positively biased iff $\bar{m}_a - \bar{m}_b > k(g(\frac{G-1}{G}) - g(\frac{1}{G}))$.
(iii) negatively biased iff $\bar{m}_a - \bar{m}_b < k(g(\frac{1}{G}) - g(\frac{G-1}{G}))$.
(iv) conformist iff $k > 0$, $|\bar{m}_a - \bar{m}_b| < k(g(\frac{G-1}{G}) - g(\frac{1}{G}))$ and $m_a(G - 1, G) < m_b(1, G)$.
When $\bar{m}_a = \bar{m}_b$, the transmission is purely conformist.

Proof. See Appendix. ■

Unless merits are equal and independent of frequency, i.e., $k = 0$ and $\bar{m}_a = \bar{m}_b$, (6) cannot generate unbiased transmission. This is the case because $f(q) = q$ (Lemma 1, (i)) requires that $P(a|n, G) = n/G$. Constant, but non equal merits always generate positive (negative bias) when $\bar{m}_a > \bar{m}_b$ ($\bar{m}_a < \bar{m}_b$). It is worth noting that conformism in the oblique transmission arises only when the magnitude of the difference in the constant part of merits of variants is not too large relative to the importance given to frequency, k. Conformism only arises if the young agent cares about frequency and perceives the different cultural variants as rather similar, i.e.; $|\bar{m}_a - \bar{m}_b|$ is small. As the difference in merits grows larger, the transmission goes from being frequency dependent, to being biased. Figure 2 illustrates three different transmission functions which differ in the strength of the negative bias, keeping k constant. The solid line satisfies the restrictions in iii) and the negative bias dominates for all q. The dashed and the dotted line illustrate case iv) as the bias is reduced the function becomes frequency dependent. Note that with a weaker negative bias (dashed line), $\hat{q}$ is smaller.

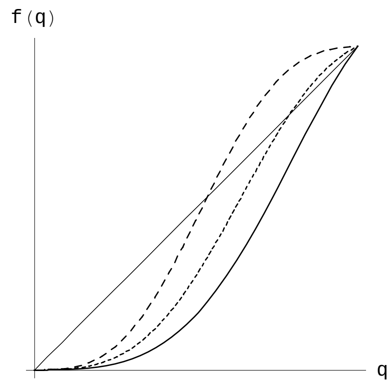

Figure 2: Changes in f due to changes in the negative bias.

IV. The dynamics of culture

We now return to the parent's problem, which was to choose x, the probability that the child adopts the a-variant, in order to maximize expected value of nurturing efforts net of costs (4). The first order condition (for an interior solution) is:

$$V^{ia} - V^{ib} = C_x(x, q) \qquad i = a, b. \tag{8}$$

Let $x(q, \Delta V^i)$ be the solution to (4) where $\Delta V^i = V^{ia} - V^{ib}$. Lemma 2 characterizes this optimal socialization probability under different assumptions regarding which type of the trait gives the highest wellbeing for the child.

Lemma 2 *Assume that* $C_{xq}(x, q) < 0$, *for all* x *then*
(i) If $\Delta V^i > 0$, $x(q, \Delta V^i)$ *is increasing in* q *and* ΔV^i, $f(q) < x(q, \Delta V^i) < 1$ *for all* $q < 1$, *and* $x(1, \Delta V^i) = f(1)$.
(ii) If $\Delta V^i < 0$, $x(q, \Delta V^i)$ *is increasing in* q *and decreasing in* ΔV^i, $0 < x(q, \Delta V^i) < f(q)$ *for all* $q > 0$, *and* $x(0, \Delta V^i) = f(0)$.

Proof. See Appendix. ■

It is worth noting that the optimal effort put forth by parents, τ_i, is decreasing in the proportion of the population having the trait parents are trying to promote.[8] In the next section we will explore the consequences of non-linear oblique transmission for the dynamics of culture with a particular focus on when diversity is sustainable and when cultural types disappear.

We follow Hauk and Sáez-Martí (2002) and assume a Poisson process for births and deaths, holding the population size constant. Let λ be the probability that an adult survives from one period to the next. Also, let $(1-\lambda)$ be the probability that an adult bears a child that reaches adulthood (with certainty) a period later. Hence, each period, a fraction $(1-\lambda)$ of the adult population have just reached adulthood after having been born and socialized in the period before. It follows that the fraction of a-variants in the population evolves as:

$$q_{t+1} = \lambda q_t + (1-\lambda)(q_t x(q_t, \Delta V^a) + (1-q_t)x(q_t, \Delta V^b)). \tag{9}$$

Eliminating time indices from (9) we can write the change in the fraction of a-types as

$$\Delta q = (1-\lambda)(q\ x(q, \Delta V^a) + (1-q)\ x(q, \Delta V^b) - q). \tag{10}$$

The net inflow of a-variants in the population is hence given by a convex combination of a-variant and b-variant parents' optimal transmission probabilities characterized in Lemma 2, where the weights change with the population share q.

We are interested in finding conditions under which (i) the different variants of the trait coexist in equilibrium even if all parents agree on which type is desirable; and (ii) when one type of the trait may disappear although parents strive to transmit their own variant. We will refer to the idea of agreement on what variant is best for children as (i) *melting pot* $(\Delta V^a = \Delta V^b)$ and to the idea that parents wish to promote their own variant as (ii) *demand for pluralism.*

First, let us show that diversity is sustainable under melting pot incentives. Let $q(t, q_0)$ denote the path induced by equation (10) when the initial condition is q_0. Let E denote the set of steady states.

Proposition 2 (Melting pot) *Assume* $\Delta V^i = \Delta V \geq 0$ *(i=a, b) then*
(i) $1 \in E$
(ii) if oblique transmission is unbiased or positively biased (in favour of trait a) then $E = \{1\}$ *and* $q(t, q_0) \to 1$ *for all* q_0.
(iii) if oblique transmission is negatively biased (against trait a) $E = \{q^*, 1\}$ *with* $q^* \in [0, 1)$ *and* $q(t, q_0) \to q^*$ *for all* $q_0 \neq 1$.
(iv) if oblique transmission is conformist and ΔV *small enough then* $E = \{q_1^*, q_2^*, 1\}$, $q_1^* < q_2^*$, $q(t, q_0) \to q_1^*$ *for all* $q_0 < q_2^*$*and* $q(t, q_0) \to 1$ *for all* $q_0 > q_2^*$. *For large enough* ΔV, $E = \{1\}$ *and* $q(t, q_0) \to 1$ *for all* q_0.

[8] Bisin and Verdier (2000) refer to this as cultural substitution.

Proof. See appendix. ■

Proposition 2, shows that diversity is sustainable under melting pot incentives if the desired trait is difficult to acquire through oblique transmission. Because parents are in a sense working uphill, the "unwillingness" of children, due to a negative bias or conformist pressure, to acquire the desired variant prevents the undesired variant from disappearing.

In Figure 3 we illustrate the cultural dynamics under melting pot incentives when the oblique transmission function is negatively biased and when there is conformism. We have plotted Δq as a function of $q \in [0,1]$. Stable steady states are marked with filled squares and unstable steady states with empty squares. It is easy to see that diversity can be sustained even in a situation in which all parents promote the same cultural variant. First, when there is a negative bias against adopting the a-variant through peer interaction, culture will always be diverse. Second, when there is conformism, it is clear that the economy converges either to a diversified culture with a "low" fraction of a-types, or if there are enough a-types to start with, the b-variant disappears.

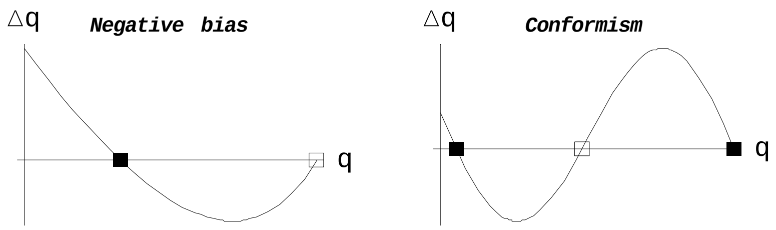

Figure 3. Melting pot incentives with negative bias and conformism.

When children are conformist, there can be multiple stable steady states. This opens up for the possibility of diversity or assimilation depending on initial conditions and has interesting implications for the effects of integration policies or policies attempting to influence the merits assigned by children to different variants of traits.

We now derive some comparative static results. Under negative and frequency dependent transmission, increasing parents' awareness of the importance of the trait (higher ΔV) increases the equilibrium values and the basin of attraction of 1 in the conformist case. An increase in the relative merit assigned to the $a-$variant has a positive effect on the equilibrium values when $\Delta V > 0$, as does an increase in the weight given to frequency, k.

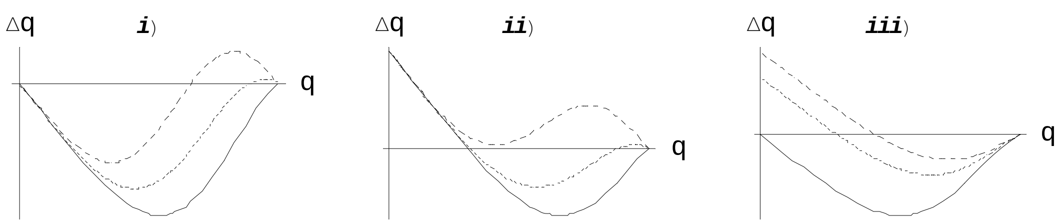

Figure 4: Changes in i) negative bias with ΔV=0 ii) in negative bias with ΔV>0 iii) in ΔV's with constant bias.

Assume that there is a negative bias against the a-variant of a trait and that there is a policy intervention that reduces the negative bias, i.e. a policy reducing $\bar{m}_b - \bar{m}_a$. Such a policy could be for instance an information campaign in schools. This leads to changes in $f(q)$ as those depicted in Figure 2, where the dotted line corresponds to a smaller reduction in the bias than the dashed one. As the negative bias decreases the oblique transmission becomes more and more conformist. The corresponding cultural dynamics resulting from such changes are represented in Figure 4 i) and ii) where the solid, dotted and dashed lines correspond, respectively, to the to the solid, dotted and dashed transmission functions in Figure 2. In panel i) parents do not invest in their children's preferences ($\Delta V = 0$) while in panel ii) both types of parents agree that a is the preferred variant ($\Delta V > 0$). Under the negatively biased transmission (solid line), there is a unique stable steady state (at $q^* = 0$ in i) and $q^* > 0$ in ii)). The change in merits increases the equilibrium proportion of a-agents only if parents are already investing in the preferred trait ($\Delta V > 0$, panel ii)). Influencing the children's merit valuation when parents do not invest in the trait, as in panel i), leaves the steady state fraction of $a-$agents constant at 0. As the transmission function becomes frequency dependent there is another stable steady state at $q = 1$. The only way to reach the new equilibrium is through big shocks changing the initial proportion of a-agents. When parents make a positive investment in transmitting the $a-$variant (panel ii)), reducing the negative bias of children always increases the steady state fraction of a-agents. Moreover, if the change in the merits is large enough (dashed line) the economy will converge to a new unique steady state with everybody having the desired trait, i.e., $q = 1$. Finally, panel iii) represents the change in the dynamics due to an increase in the parents' evaluation of the $a-$variant, keeping the negative bias constant. This policy always increases the equilibrium proportion of a-agents. The solid line corresponds to $\Delta V = 0$, the dotted and dashed lines to positive ΔV with the latter being larger. This example suggests that policies may be more effective if they try to affect both parents awareness of the importance of a trait and children's relative merits.

Next we consider the cultural dynamics under the type of parental preferences that have been analyzed in the previous literature, namely the demand for pluralism.

Proposition 3 (Demand for pluralism) *Assume* $\Delta V^b < 0 < \Delta V^a$ *then*
(i) $\{0,1\} \subseteq E$.
(ii) if oblique transmission is unbiased $E = \{0, q^*, 1\}$ *and* $q(t, q_0) \rightarrow q^*$ *for all* $q_0 \in (0, 1)$.
(iii) if oblique transmission is negatively biased (against trait a) $q = 1$ *is always unstable and* $q = 0$ *is stable for small enough* ΔV^a. *There may exist interior stable steady states.*
(iv) if oblique transmission is positively biased (in favour of trait a) $q = 0$ *is always unstable and* $q = 1$ *is stable for small enough* ΔV^b. *There may exist interior stable steady states.*
(v) if oblique transmission is conformist, 0 *is stable for small enough* $\Delta V^a, 1$ *is stable for small enough* ΔV^b. *For small enough* ΔV^a *and* ΔV^b *there always exist a interior unstable steady state. For large enough* ΔV^a *and* ΔV^b *there always exist at least one interior stable steady state. There may exist multiple interior stable steady states.*

Proof. See appendix. ■

Proposition 3 (ii) confirms the standard result in the literature, namely that if parents promote their own trait and oblique transmission is linear, diversity is guaranteed. However, this guarantee fails when oblique transmission is biased, since also desired traits may die out. When the bias is positive or negative, the variant at risk is the one with a bias against it. It is only when parents who hold that trait attach enough value to it that there is room for coexistence of the two traits in equilibrium. Intuitively, conformism can put all minority traits at risk of extinction.

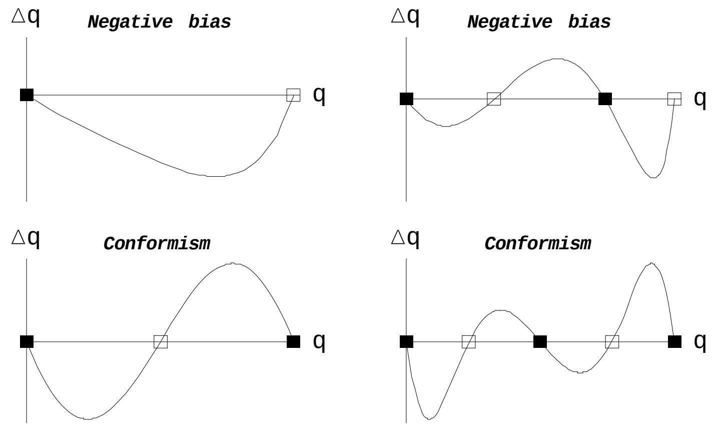

Figure 5. Demand for pluralism. Dynamics under negative bias and conformism.

Figure 5 depicts the cultural dynamics when there is demand for pluralism under different biases in the oblique transmission function. The black (white) squares are the stable (unstable) steady states. The top panels illustrate the negative bias, and the bottom panels the conformism. It is evident from this figures that with negative bias and conformism variants may be at risk, even if there is demand for pluralism. It is also evident that the cultural dynamics with biased oblique transmission are far more complex than when linearity is assumed. Recall that when there is demand for pluralism and linear oblique transmission, there is a unique and interior stable steady state.

We now turn to some comparative statics which analyze how the introduction of biases changes the main prediction of the standard model of cultural transmission (Bisin and Verdier, 2001), i.e. existence of a unique stable (interior) steady state. Consider first panel i) in Figure 6 where the initial dynamics, with linear transmission and demand for pluralism, are shown by the solid line. As children become negatively biased against trait a, there is a decrease in the equilibrium proportion of a-agents (dashed line). If the negative bias becomes strong enough, the population will eventually consists of only b-types (dotted line). Panel ii) shows how the introduction of conformism turns 0 and 1 which under a linear f are unstable (solid line) into stable steady states. As the conformism becomes stronger (dotted line) the initial stable interior equilibrium becomes unstable. For small levels of conformism, though, there may exist an interior stable steady state (dashed line). As these examples show, changes in the transmission function can have large effects in the long run distribution of traits.

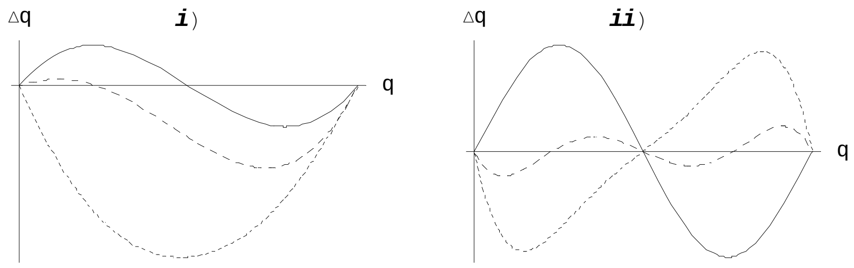

Figure 6. Introduction of i) negative bias and ii) conformism.

It is also worth noting that under demand for pluralism, policies affecting the parents evaluations may be ineffective. Consider Figure 7. In panel *i*) the solid line represents the dynamics with negative bias against the *a*-variant and demand for pluralism, i.e. $\Delta V^b < 0 < \Delta V^a$. Policies aiming at increasing the proportion of a-agents in the population and that target parents evaluations i.e. increasing ΔV^a and ΔV^b (dashed line) do not change qualitatively the dynamics (dotted line). Similarly if the transmission is frequency dependent as shown in panel *ii*). If the initial steady state is $q = 0$, policies which only target parents evaluations are bound to fail. Reducing the negative bias and the extent of frequency dependence are more effective in increasing the steady state proportion of a-agents as it can be seen in Figure 6.

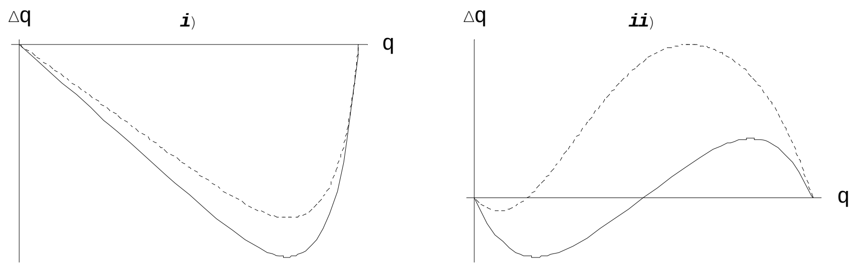

Figure 7. Changes in parents evaluation i) with negative bias and ii) with conformism.

V. Conclusion

We have shown that when children evaluate the merit of cultural variants and adopt culture as a result of interaction with peers, cultural diversity is not guaranteed by a demand for cultural pluralism on the part of parents. We have also shown that there can be diversity even if all parents promote the same cultural variant. Furthermore, we show that the biases in the oblique transmission function than result from merit guided cultural adoption opens up for multiple stable steady states. Our model, therefore, provides a rich framework for understanding the underlying driving forces of cultural assimilation and stratification which modifies the conclusions of previous models of cultural transmission.

Our results provide new interpretations of empirical evidence and new predictions regarding the effects of integration policies. For instance, it need not be correct to interpret the disappearance of a cultural variant as resulting from a reversal of parental valuation of the benefits of holding different variants. Our model predicts that a trait can disappear as a result of integration of a community into another one, not because parents change their mind about the benefits of variants, but because the composition of peer groups change. In earlier models of cultural dynamics, even a tiny fraction of families with "bad" habits could contaminate a purely "good" neighborhood. When there is conformism, this is no longer the case. Neither is this the case if children are biased in favor of "good" habits.

Our model also helps us understand the reasons why economically dysfunctional or otherwise unhealthy cultural variants may persists. In particular, if children are biased in favour of liking unhealthy food or of taking it easy, or even if they just like to eat what others eat or shirk as others do, parents of all types, may try in vain to promote good eating or work habits. It may be the case that, due to different initial conditions, in some communities parents have to put a lot of effort into combatting bad but persistent habits, while in other communities parents need not worry much.

This paper recognizes that parental ambitions and incentives are indeed important, but because young individuals are not passive receivers of culture, the processes of assimilation and stratification are not only up to parents. A natural extension of the present paper is to model the role of policy makers, and to analyze how parents and policy makers can influence the biases in the process of oblique transmission.

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Appendix
Proof of Lemma 1

$$\begin{aligned} \sum_{n=0}^{G} \binom{G}{n} q^n (1-q)^{G-n} \frac{n}{G} &= \sum_{n=1}^{G} \binom{G}{n} q^n (1-q)^{G-n} \frac{n}{G} = \\ q \sum_{n=1}^{G} \binom{G}{n} q^{n-1} (1-q)^{G-n} \frac{n}{G} &= q \sum_{n=0}^{G-1} \binom{G-1}{n} q^n (1-q)^{G-1-n} = q. \end{aligned} \tag{A1}$$

The last equality follows from the binomial theorem:

$$\sum_{n=0}^{T} \binom{T}{n} q^n p^{T-n} = (q+p)^T. \tag{A2}$$

Proof of Proposition 1

From Lemma 1 it follows that if $P(a|n,G) > (<) n/G$ $\forall n$ then $f(q) > (<) q$ for $q \in (0,1)$.

i) If $k = 0$ and $\bar{m}_a = \bar{m}_a$ then $P(a|n,G) = \frac{n}{G}$ $\forall n$ and Lemma 1, applies.

ii) Assume now that $k \neq 0$. $P(a|n,G) > n/G$ whenever

$$\bar{m}_a - \bar{m}_b > k(g(\frac{G-n}{G}) - g(\frac{n}{G})). \tag{A3}$$

The RHS in (A3) is decreasing in n. $P(a|n,G) > n/G$ $\forall n$ whenever (A3) holds for $n = 1$.

iii)Assume now that $k \neq 0$. $P(a|n,G) < n/G$ whenever

$$\bar{m}_a - \bar{m}_b < k(g(\frac{G-n}{G}) - g(\frac{n}{G})). \tag{A4}$$

The RHS in (A4) is decreasing in n. $P(a|n,G) < n/G$ $\forall n$ whenever (A4) holds for $n = G-1$.

iv) Note first that $f'(0) = G(P(a|1,G) - P(a|0,G)) = GP(a|1,G)$ and $f'(1) = G(P(a|1,G) - P(a|G-1,G) = G(1 - P(a|G-1,G)$. If

$$k(g(\frac{1}{G}) - g(\frac{G-1}{G})) < \bar{m}_a - \bar{m}_b < k(g(\frac{G-1}{G}) - g(\frac{1}{G})), \tag{A5}$$

then $P(a|1,G) < 1/G$ and $P(a|G-1,G) > (G-1)/G$ and, $f'(0) < 1$,$f'(1) < 1$ and there is a unique $\bar{q} \in (0,1)$ such that $f(\bar{q}) = \bar{q}$.

When $\bar{m}_a = \bar{m}_b$ and $k \neq 0$, $P(a|n,G) = 1 - P(a|G-n,G)$ and since $\binom{G}{n} = \binom{G}{G-n}$,

$$f(q) = 1 - f(1-q), \tag{A6}$$

and $f(1/2) = 1/2$.

Proof of Lemma 2

If $\Delta V > 0$ and $q \neq 1$, $x(q, \Delta V^i) > f(q)$ and $C(x,q) = c_a((x - f(q))(1 - f(q))^{-1})$. If follows from $c_a'' > 0$ that $x(q,\Delta V)$ is increasing in ΔV^i. To see this, from the first order condition we have that

$$\Delta V \equiv c_a'(\frac{x(q,\Delta V) - f(q)}{1 - f(q)})(1 - f(q))^{-1}. \tag{A7}$$

Differentiating with respect to ΔV gives:

$$1 = c_a''((x(q,\Delta V) - f(q))(1 - f(q))^{-1})(1 - f(q))^{-2} x_{\Delta V}(q, \Delta V). \tag{A8}$$

Hence, $x_{\Delta V}(q,\Delta V) > 0$. To see that $x(q,\Delta V)$ is increasing in q, differentiate the first order condition with respect to q and rearrange to get:

$$x_q(q,\Delta V) = f'(q)(\frac{1 - x(q,\Delta V)}{1 - f(q)} - \frac{c_a'(\tau_a(q,\Delta V))}{c_a''(\tau_a(q,\Delta V))}). \tag{A9}$$

The assumption $C_{xq}(x,q) < 0$ implies that the second term in the RHS is positive. Since $f'(q) > 0$, it follows that $x_q(q,\Delta V) > 0$. The proof for Lemma 1(ii) is analogous.

Proof of Proposition 2

Since $\Delta V^i = \Delta V$, it follows from (10) that $\Delta q = (1-\lambda)(x(q,\Delta V) - q)$ and $\Delta q = 0$ whenever $x(q,\Delta V) = q$.

i) It follows from the fact that $x(1,\Delta V) = 1$.

ii) Since $x(q,\Delta V) > f(q)$ when $\Delta V > 0$ and $q < 1$ (Lemma 1) then $\Delta q > 0$ whenever $f(q) \geq q$. Evaluating the derivative of Δq with respect to q at $q = 1$ we obtain

$$\frac{d(\Delta q)}{dq}|_{q=1} = (1-\lambda)(f'(1) - 1), \tag{A10}$$

and $q = 1$ is stable whenever $f'(1) \leq 1$.

iii) At $q = 0$, $\Delta q > 0$ since $x(q,\Delta V) > 0$. Moreover

$$\frac{d(\Delta q)}{dq}|_{q=0} = (1-\lambda)(f'(0)(\frac{1-x(0,\Delta V)}{1} - \frac{c_a'(\tau_a(0,\Delta V))}{c_a''(\tau_a(0,\Delta V))}). - 1) < 0. \tag{A11}$$

At $q = 1$, $\Delta q = 0$ since $x(1,\Delta V) = 1$. Moreover

$$\frac{d(\Delta q)}{dq}|_{q=1} = (1-\lambda)(f'(1) - 1) > 0. \tag{A12}$$

Hence, there is a stable interior rest point.

iv) If transmission is frequency dependent, $f(q)$ has three fixed points, $q = 0, \hat{q}, 1$. Since $x(0,\Delta V) > 0$ and $\lim_{\Delta V \to 0} x(q,\Delta V) = f(q)$, for small enough ΔV, $x(q,\Delta V)$ has also three fix points, $E = \{q_1(\Delta V), q_2(\Delta V), 1\}$ with $\lim_{\Delta V\to 0} q_1(\Delta V) = 0$ and $\lim_{\Delta V \to 0} q_2(\Delta V) = \hat{q}$. For large enough ΔV , $x(q,\Delta V) > q$ for $q < 1$ and $\lim_{t\to\infty} q(t,q_0) = 1$.

Proof of Proposition 3

i) If $\Delta V^b < 0 < \Delta V^a$, $x(0,\Delta V^b) = 0$, $x(q,\Delta V^a) = 1$ and $\Delta q = 0$ at $q = 0, 1$.

From (10) and the first order conditions,

$$\Delta q = (1-\lambda)(c_a'^{-1}(\Delta V^a(1-f(q)))q(1-f(q)) - c_b'^{-1}((-\Delta V^b)f(q))f(q)(1-q) + f - q), \tag{A13}$$

for $\Delta V^b < 0 < \Delta V^a$. Taking the derivative with respect to q and evaluating at 0 and 1 we obtain:

$$\frac{d(\Delta q)}{dq}|_{q=0} = (1-\lambda)(c_a'^{-1}(\Delta V^a) + f'(0) - 1), \tag{A14}$$

$$\frac{d(\Delta q)}{dq}|_{q=1} = (1-\lambda)(c_b'^{-1}(-\Delta V^b) + f'(1) - 1). \tag{A15}$$

It is easy to see that:

a) $f\prime(0) \geq 1 \Rightarrow \frac{d(\Delta q)}{dq}\rceil_{q=0} > 0$ and $f\prime(0) < 1$, $\frac{d(\Delta q)}{dq}\rceil_{q=0} \gtreqless 0$ when $c_a'^{-1}(\Delta V^a) \gtreqless 1 - f'(0)$.

b) $f\prime(1) \geq 1 \Rightarrow \frac{d(\Delta q)}{dq}\rceil_{q=1} > 0$ and $f'(1) < 1$, $\frac{d(\Delta q)}{dq}\rceil_{q=1} \gtreqless 0$ when $c_b'^{-1}(-\Delta V^b) \gtreqless 1 - f'(1)$.

ii) That $q = 0, 1$ are unstable follows from i, a) and i, b) . Since $c_a'^{-1}(\Delta V^a(1-q))$ is decreasing in q and $c_b'^{-1}((-\Delta V^b)q)$ is increasing there is a unique interior rest point q^*. Stability follows from the fact that $c_a'^{-1}(\Delta V^a(1-q)) \gtreqless c_b'^{-1}((-\Delta V^b)q)$ whenever $q \lesseqgtr q^*$.

iii)-v) follows from i, a) and i, b).